METHOD OF GLUING AND APPARATUS THEREFOR

The present invention relates to the manufacture of composite products, wherein a plurality of elements are assembled by gluing them together. In particular it relates to mechanical application of glue in such manufacture.

Background of the Invention

For the manufacture of products comprising a plurality of elements that are assembled by gluing, sometimes large amounts of glue are applied to large surfaces. In cases where several elements exhibiting such large surfaces are to be assembled one after the other, substantial waiting times may occur before the assembly of elements can be finally processed e.g. in a press, where the curing of the glue takes place. In such instances, for example, in the production of laminated wood, the first element to which glue was applied will have to wait longer than the last element. The amount of glue that is applied to each element is calculated based on the waiting time for the element that has the longest waiting time. This leads to a waste of glue and therefore economic disadvantage.

Commonly used glues are e.g. PRF (Phenol Resorscinol Formaledhyde; two component glue), MUF (Melamine Urea Formaldehyde; two component glue), PUR (Poly urethane; one component glue). In the case of two components, each component can be applied separately or they can be mixed before application.

Summary of the Invention

Thus, the present invention seeks to provide a method and apparatus that reduces the total amount of glue that is used in the manufacture of composite structures.

The method according to the invention is defined in claim 1.

By controlling the amount of at least one component of a glue applied in relation to the waiting time before a glued object is subjected to final compression treatment in a press, a reduction in glue consumption is achieved.

Preferably the amount of glue is also adapted to other factors such as moisture content in the material to be glued and in the ambient atmosphere, hardness of the material, porosity etc.

A number of different materials can be processed, e.g. metal, polymers, ceramics, wood. In preferred embodiments the material to be processed by the method of the invention is wood.

An apparatus for manufacturing composite products using an optimal amount of glue is defined in claim 14, and an apparatus for the controlled glue application is defined in claim 17.

Brief Description of the Drawings

Fig. 1 schematically shows a manufacturing station for the production of glued structures;

Fig. 2a shows one type of press;

Fig 2b shows an example of the glue application profile according to the invention for the press of Fig. 2a;

Fig. 3a shows another type of press;

Fig 3b shows an example of the glue application profile according to the invention for the press of Fig. 3a;

Fig. 4a shows a third type of press;

Fig 4b shows an example of the glue application profile according to the invention for the press of Fig. 4a; and

Fig. 5 is a flow chart of an embodiment of the control process.

Detailed Description of the Invention

A first embodiment of the invention will now be described with reference to the manufacture of a laminated beam consisting of a stack of individual lamellas glued and pressed together to

form the beam, and a schematic illustration of a manufacturing station for this purpose is shown in Fig.1. However, the principle is usable for all kinds of products that are glued together and subjected to pressure for glue hardening purposes.

The manufacturing station comprises a supply unit 2 for individual lamellas 4. The supply unit can be any kind of transport device that is able to position one lamella at a time on a conveyor belt 6 or the like, used for feeding the lamellas into the processing portion of the manufacturing station. The supply unit could even be an operator, manually placing each individual lamella on said conveyor.

The processing portion comprises in the shown embodiment five units: a planer device 8; a glue applicator 10; a stacking unit 12 where a “precursor beam” 14 is assembled; a control unit 15 (e.g. a PC or other micro processor device) and operating panel; and a press 17.

The control unit 15 is supplied with data for the specific product to be manufactured, either by an operator or in digital form from a central computer or by data on diskettes etc. Details of the control program will be given below.

The procedure is thus the following: a first lamella 4 is placed on the conveyor or feeder 6, fed into the planer device 8, where the lamella is suitably surface machined. This unit comprises guide rolls and machining tools, and therefore it can also be used for controlling the speed of the lamella through the station. However, the planer device can be dispensed with if the raw material is of high quality and does not need to be treated, and if the speed of the lamellas can be controlled by the conveyor 6, or by the glue applicator 10.

After having (optionally) been surface machined, the lamella 4 is fed through the glue applicator 10. The glue amount that is applied to the lamella is controlled in a way to be described below, and will vary from lamella to lamella automatically according to the control program, adapted for each individual product type and environmental conditions prevailing in the plant.

After having been provided with the appropriate amount of glue, the lamella 4 on exiting from the glue applicator 10 will be moved forwards by a second conveyor 16 to a stop 18. Then, the lamellas will be moved from the conveyor 16 to the side where they are placed on top of each other until the desired number of lamellas have been assembled to a pile or stack. The

assembly is then transported to a press where the pile is subjected to a suitable pressure, and if required to heat, for a sufficient period of time to harden the glue. This part of the process does not form part of the invention per se, and is common knowledge for the skilled man, and will therefore not be described in further detail.

Preferably there will be provided a sensor 20 for counting the number of lamellas passing the glue applicator, or for measuring the number of linear meters that has been fed through the station. The data from the sensor is fed to the control unit 15.

There are several possible types of press usable for the manufacture of laminated products.

A first example is shown in Fig. 2a. It is a full length press, i.e. it will exert a pressure over the entire assembly of glued lamellas at one and the same time, and thus all parts will be pressed simultaneously, therefore the pressing operation itself will not cause any additional waiting times that must be considered in the glue application.

In contrast, the press shown in Fig. 3a, which is a section press, will press only part of the assembly in a first pressing operation, and then continue along the length of the assembly in several operations, that may or may not be overlapping. In this case obviously the last section to be pressed has to wait additional time, and thus the amount of glue is optimized also in accordance therewith.

A third alternative is shown in Fig. 4a, which shows a continuously working press, i.e. the pressure is applied by means of rollers acting on the upper surface of the pile or stack of lamellas. The assembly is then fed continuously through the press.

Obviously the glue application profiles for these alternatives differ, and the profile for each respective type of press is shown in Figs. 2b-4b.

In the case of a full length press, as already mentioned, there is no waiting time caused by the pressing operation as such, and the only waiting times to consider are the waiting times for each lamella during the gluing and stacking process. Thus, as shown in Fig. 2b there is a constant amount of glue applied over the entire surface or length of each lamella, but the amount of glue will differ between lamellas. ◆ designates the glue applied in accordance with the invention, and ■ the traditional spread of glue.

In the second case, with sections pressed one at a time, there will obviously occur a waiting time between each consecutive pressing operation, and consequently the glue must be applied differently over the length of the lamellas. The glue amounts increase in increments over the length, and the glue application profile is shown by the left hand bars in the bar chart in Fig. 3b (the bars of equal length represent traditional glue spread). Thus, the section subjected to the compression first (section A in Fig. 3b) will have a smaller amount of glue applied than the following sections, since the waiting time is highest for the higher "numbered" sections.

In the continuous glue application case, there will of course be a continuously increasing amount of glue needed to be applied as a function of increasing waiting time, as clearly seen in Fig. 4b, wherein ♦ designates the amount of glue as a function of linear meters of product, according to the invention, and ■ designates traditional glue application.

Of course the optimal application of glue would be a combination of a varying application on one hand between lamellas, but also over the length of a lamella.

The amount of glue to be applied to each element can be controlled in several ways.

It is possible to have the control unit control at least four different parts of the system shown in Fig. 1, namely a) the conveyor 6; b) the planer device 8; c) the glue applicator 10; and d) the second conveyor 16.

Thus, obviously the amount of glue that is applied to an element passing through the glue applicator 10, will change if the speed through the applicator changes; rapid movement will yield a thinner glue layer, and a slow movement a thick layer. As can be easily understood, by running at a constant speed and then simply reducing the speed abruptly at half length of an element, two distinct areas having different amounts of glue applied are achieved.

On the other hand it is equally easy to increase or decrease the speed continuously, thereby obtaining a linear “gradient” of glue over the length of an element.

For the simple case where there is only a need to change the amount between elements, the speed is kept constant over the entire length of each lamella. This would correspond to the

situation in Fig. 2a where a full length press is used, and the bottom lamella is the first to which glue was applied, thus having the longest waiting time.

If the planer device 8 is used, as already indicated its guide rolls and/or machining tools can be used to force the lamellas 4 through the system, and thus the speed control can be obtained by controlling the planer device 8.

It is possible to use the second conveyor 16 too for speed control, although this would require slightly more complicated means. E.g. a connection to the conveyor would have to be provided such that the conveyor pulls the lamella through the applicator 8, thereby acting as a feeder device.

Of course the glue applicator itself can be used to control the amount of glue applied. Several possibilities exist. In the first place it is dependent on the type of applicator. An applicator normally is of either of a string type or of a curtain type. As indicated by these designations, the first applies only an essentially linear string of glue, preferably to narrow objects. A curtain applicator spreads the glue over a wide area, up to as much as several meters in width.

One way of controlling the amount of glue applied at a constant speed of the elements, is of course to control the pumped flow of the glue.

Another way is to change the "working" width of the ribbon spreader pipe, for a string type applicator simply by reducing or increasing the number of nozzles which are open, by turning the spreader pipe. For a curtain type of applicator the slit width can be varied.

Combinations of speed of element movement and of applicator settings are of course also conceivable.

In the case where a two-component adhesive is employed, it is possible to control the mixing ratio of hardener to glue. The more hardener the faster the hardening and the less the allowed waiting time. Thus, the first element of a series of elements to be assembled should be provided with adhesive, the ratio between hardener and glue of which should be lower than the ratio for the last element.

EXAMPLES:

In the following examples a glue of the PRF type has been used.

Example 1

A construction beam made up of 21 pieces is manufactured by assembling lamellas and pressing in a full length press. The piece to which the glue is applied first has a waiting time of 1 hour, and the last piece has a waiting time of 10 minutes. The following glue application profile will be employed.

Lamella No.	Amount of glue (g/m^2)
1	500
2	488
3	476
4	464
5	452
..	
..	
21	300

The profile is illustrated graphically in Fig. 2b for above assembly of 21 pieces.

The amount of glue per m^2 can of course vary, and commonly does so between 100-300 g/m^2 for 10 minutes waiting time, and between 300-500 g/m^2 for 1 hour waiting time. As already indicated above moisture content in the material, humidity in the atmosphere, ambient temperature, will also influence the amount glue to be applied.

Example 2

A construction beam made up of 21 sections as in Example 1 is made, but instead of a full length press a section press is used (Fig. 3a). Thus, it becomes preferred to apply different amounts of glue on the various sections of each piece, in addition to varying the amount from one lamella to another, see Fig. 3b, wherein the black bars represent the glue application

according to the invention, and the white bars represent traditional application. In the example the beam is pressed in 5 sections (A-E, where A is the section that will enter the press first).

Lamella No.	Amount of glue (g/m^2) on each section				
	A	B	C	D	E
1	342	392	442	492	542
2	340	390	440	490	540
3	338	388	438	488	538
4	336	386	436	486	536
5	334	384	434	484	534
	..				
	..				
21	300	350	400	450	500

In the pile of lamellas, lamella no. 21 will be the top lamella, thus having the shortest waiting time.

Example 3

A construction beam made up of 21 lamellas as in Example 1 is made, but instead of a full length press a continuously operating press is used. Thus, it becomes preferred to apply a gradient of the amounts of glue over the length of each piece. Strictly speaking it is not necessary to apply a continuously changing amount, it would suffice to increment the amount as if the press is operated as a section press with a very large number of sections. In this context "very large" could mean 20 sections or more.

The profile in Fig. 4b adequately illustrates the required profile for one of the lamellas in a beam.

Fig. 5 is a flow chart that illustrates one embodiment of the control program for controlling the glue application in accordance with the inventive concept.

It assumes that a one-component glue is used, and that the process is for the manufacture of a beam comprising a number of lamellas to be assembled.

Thus, the first step is to set the number of lamellas to be assembled, and data relating to environment (e.g. humidity as in the example, although other factors might be considered too), and to material properties, e.g. hardness, porosity etc. From this input data and data from a data base containing information about glue behaviour under different circumstances, the necessary minimum and maximum glue amounts are calculated for each lamella.

Next, the type of press is selected, and in case of a section press, the number of sections is set. Also in response to the press selection, the glue applicator is set for constant application or stepwise or continuous change of glue application.

The invention has been describe with reference to some embodiments, but the skilled man will find various modifications without departing from the scope of invention as defined in the claims.